PIBS# 693E

ECONOMIC ASSESSMENTS OF MISA REGULATIONS FOR DIRECT INDUSTRIAL DISCHARGERS IN ONTARIO

By:

Orna E. Salamon and Jack A. Donnan

Socio-Economics Section
Policy and Planning Branch
Environment Ontario

A Paper Presented at the
Technology Transfer Conference
Toronto, Ontario
November 28, 1988

ECONOMIC ASSESSMENTS OF MISA REGULATIONS FOR DIRECT INDUSTRIAL DISCHARGERS IN ONTARIO

By:

Orna E. Salamon and Jack A. Donnan

Socio-Economics Section
Policy and Planning Branch
Environment Ontario

A Paper Presented at the
Technology Transfer Conference
Toronto, Ontario
November 28, 1988

ABSTRACT

The Municipal-Industrial Strategy for Abatement (MISA) is a major initiative of the Ontario Ministry of the Environment, and is intended to achieve "virtual elimination of toxic contaminants in municipal and industrial discharges into waterways." Key elements of the program will be comprehensive monitoring and discharge limits regulations that will be applied to all municipal and industrial wastewater dischargers. An economic component of the MISA program is designed to assess the economic implications of the proposed regulations prior to their implementation. Economic profiles have been prepared for each of 9 industrial sectors whose direct discharges into provincial waterways will be regulated under the MISA program. Estimates of the costs of MISA monitoring regulations are being generated for each sector and the efficiency and distributional implications of these costs are being assessed. To the extent possible, cost-effectiveness of the proposed requirements are being examined. Preliminary results indicate that monitoring requirements alone will total approximately $3.5 million for Ontario Petroleum refineries and $8.9 million for 19 organic chemical manufacturing plants in the province over the 12-month period of the regulations.

TABLE OF CONTENTS

1.0 Introduction....................................1

- 1.1 Overview of the MISA Program........................1
- 1.2 Plan of Paper....................................4

2.0 Socio-Economic Analyses..............................4

- 2.1 MISA Economic Program............................5
- 2.2 Concept of "Economically Achievable"................8

3.0 Industry Profiles.....................................12

- 3.1 Methodology.....................................12
- 3.2 Sector Profiles...................................15
  - 3.2.1 Definition of the Industrial Sector.......15
  - 3.2.2 Market Structure..........................17
  - 3.2.3 Trends and Forecasts......................22

4.0 Estimated Cost of Monitoring............................29

- 4.1 Methodology.....................................29
- 4.2 Estimated Costs of Monitoring and Their Implications..32
  - 4.2.1 Comparison of the Petroleum and OCM Sectors..............................41

5.0 Future Analytical Work................................44

6.0 Conclusions...45

References..47

Appendix A List of Selected MISA Sectors and Firms

Appendix B Industry Profiles Terms of Reference

LIST OF TABLES

1. Economic Components of MISA....7

2. USEPA Economic Impact Analysis....10

3. Financial Indicators....13

4. Financial Impacts of Estimated Monitoring Costs on the Consolidated Petroleum Products Segments of Petroleum Companies....36

5. Financial Impact of Monitoring Costs - OCM Sector....40

6. Comparison of Total Costs by Monitoring Function....41

7. Comparison of Total Monitoring Costs....43

LIST OF FIGURES

1. Simplified Flowchart of Ontario Petrochemical Industry Interdependence in Sarnia, Ontario....21

2a. Retail Gasoline Price Structure - Toronto Region January 1986....23

2b. Retail Gasoline Price Structure - Toronto Region April 1986....23

3. After-Tax Profit - Petroleum Sector 1981-1985....25

4. Cash Flow - Petroleum Sector 1981-1985....25

5. Net Income (Loss) - OCM Sector 1983-1987....27

6. Internal Cash Flow - OCM Sector 1983-1987....27

7. Typical Industrial Plant Site Monitoring Locations....33

8. Costs by Monitoring Function....42

1.0 INTRODUCTION

This paper presents an overview of the economic assessment program supporting the Ministry of the Environment's MISA initiative. The principles and scope of this program are integral to all MOE initiatives. The analytical work carried out to assess the economic and financial implications on direct industrial dischargers of the MISA monitoring and abatement regulations will be the focus of the present paper.

1.1 Overview of the MISA Program

The Municipal-Industrial Strategy for Abatement (MISA), was announced by the Ontario Ministry of the Environment in June 1986. MISA is intended to achieve the "virtual elimination of toxic contaminants in municipal and industrial discharges into waterways" (MOE[16] p.7). The MISA program will encompass over 200 mines and industrial establishments in Ontario which discharge their wastewaters directly into provincial waterways. In addition, over 400 municipal sewage treatment plants, which receive wastewaters from nearly 12,000 industrial plants will be subject to tighter controls under the MISA program.

As discussed in the "White Paper" (MOE[16]), the MISA program includes :

1. Establishing regulations which require each plant to monitor its effluent for a wide range of contaminants.

2. Development of regulations which will specify effluent limits which are based on "best available technology, economically achievable" (BATEA), or on water quality impacts, whichever is more stringent.

3. Implementation of enforcement activities to ensure that all

the specified monitoring and effluent limits are implemented according to program requirements.

4. Full public consultation, including the general public and interest groups, in developing the MISA program and regulations.

For the purposes of the MISA program, industrial establishments which are direct dischargers to provincial waterways are disaggregated into industrial sectors. Monitoring and effluent limits will be developed for the following sectors over the next three years. Additional industries may be defined as necessary.

- petroleum refining
- organic chemical manufacturing
- pulp and paper
- iron and steel
- metal mining and refining
- industrial minerals and manufacturing
- electric power generation
- inorganic chemicals
- metal castings

A list of the firms and plants included within the first two industrial sectors as of October 1, 1988 is found in Appendix A.

To achieve the fourth objective, public consultation, Joint Technical Committees have been established for each MISA industrial sector and for municipal sewage treatment plants. These Committees are comprised of provincial, federal and industry representatives who develop the actual regulations. The draft regulations and other components of the MISA program are also reviewed by the MISA Advisory Committee which is made up of representatives from public interest groups.

Monitoring requirements common to each of these sectors are specified in the "Effluent Monitoring - General" Regulation (MOE[14]). Included are sampling, analytical requirements, toxicity testing, flow measurement, recording and reporting protocols. This 'General Regulation' came into force on June 7, 1988 together with the first sector-specific regulation for the petroleum refining sector.

The general regulation will continue in force for each MISA sector while industry-specific regulations will be promulgated for each of the remaining sectors.

Once the results of detailed monitoring in each sector are available, effluent limit regulations can be specified.

Another component of MISA is a major Sewer Use Control Program which is aimed at contaminants being discharged through sewage treatment plants. The principles and elements which constitute the foundation of the proposed MISA Sewer Use Control Program are (Dillon[6]):

a) Control of indirect dischargers at the source.
b) Use of BATEA to set provincial discharge limits.
c) Application of more stringent discharge limits on a site-specific basis where necessary.
d) Require municipalities to act as the first line of enforcement.
e) Full public involvement.
f) Provincial legislative changes to give municipalities and the province the authority to obtain information and promulgate regulations.
g) Provincial auditing of municipal sewage treatment plant and industrial sewer user discharge data.
h) Provincial and municipal cost sharing schemes.

1.2 Plan of Paper

The purpose and components of the MISA socio-economic program are presented in Section 2. Some key economic principles which support such analytical work is also reviewed. Sections 3 and 4 then examine the economic assessments and evaluations that have been performed to-date, and preliminary results of this work are described. Section 5 looks at ongoing work.

2.0 SOCIO-ECONOMIC ANALYSES

The monitoring and abatement requirements that will result from the MISA program will likely be costly to achieve. Such expenditures could likely divert money and effort from other beneficial uses by government and private industry. Consequently, information on the costs of different means of achieving these requirements and their impacts on firms, industrial sectors, municipal governments, and provincial expenditure and staffing requirements is of vital interest to the Ministry of the Environment as well as industrial sectors subject to the MISA requirements.

A comprehensive economic assessment would require that information on the potential beneficial consequences of each of the regulations and other elements of the MISA program be developed and compared with the estimated costs. Benefits of the control of toxic contaminants include reduced risk to human health, protection of aquatic organisms and enhanced resource preservation.

However the MISA White Paper states that the technology-based effluent limits will be based on "best available technology, **economically achievable**". Criteria must therefore be developed that define "economically achievable" and data must then be gathered that will permit assessment of the impacts of the costs of monitoring and abatement in each industrial sector and, where possible, on individual firms or plants. Where the costs of compliance with the proposed regulations are found to be especially burdensome, information of the expected benefits of the requirements would help to choose what course of action might be taken.

2.1 MISA Economic Program

A program of economic studies has been initiated to generate the required information and to complement technical assessments and regulation development efforts. This program is outlined in a report entitled "Economic Information Needs and Assessments for Developing MISA Monitoring and Abatement Requirements" (MOE[9]).

The objectives of the economic program are:

a) to develop an economic database for those industrial sectors which will be subject to MISA monitoring and effluent limits regulations;

b) to develop estimates of the costs of proposed monitoring and effluent limits regulations for each industrial sector and for municipalities;

c) to determine the economic effects and consequences of these costs;

d) to develop criteria with which to define best available technology, economically achievable;

e) to design implementation programs that will achieve the MISA goals and objectives at least cost;

f) to contribute to the design of more effective policies and programs to control sewer uses by industrial dischargers; and

g) to provide information about the beneficial consequences of the various monitoring and abatement requirements including changes in the risk of certain health effects.

The economic program began with the preparation of industrial economic profiles for each sector. These profiles include physical and economic data, financial performance ratios, current trends, and forecasts of future market production and consumption trends. These profiles are discussed further in Section 3 of this report.

Following the production of economic profiles, studies are being carried out to estimate the costs of the proposed monitoring requirements for each sector and on individual firms and their plants, and to assess the economic and financial implications of these costs. These evaluations have aided Ministry personnel and the Joint Technical Committee in determining the most cost-effective methods of monitoring for selected contaminants. The cost of monitoring studies also identify those firms or plants which might be unduly affected by the regulatory requirements, and finally, judgements about the equity of the various program elements can be formulated.

By the end of the 12-month monitoring period, effluent limits regulations for each direct discharge sector will be developed. Abatement technologies to achieve MISA objectives will be identified and related costs estimated for each industrial sector. A key objective will be to find combinations of technologies that will achieve the MISA objectives at least-cost and to define criteria to help judge what is "economically achievable".

Estimates of the relevant costs are being prepared and financial impacts of MISA requirements are being evaluated for both direct and indirect dischargers. In addition, it is recognized that many of these industrial sectors will incur costs related to the control of both direct and indirect discharges. Therefore the total, or net impacts on these industrial sectors are being carefully analyzed.

Table 1 below summarizes the economic program in relation to major MISA phases.

Table 1

Economic Components of MISA

MISA Phase	Economic Component
Pre-Regulation	* Industrial profiles - sector/firm/plant physical and economic characteristics - historical financial ratios - current and future market trends * Municipal Sewer Use Program Assessment (indirect industrial dischargers) - evaluate the proposed Sewer Use Control Programs with an emphasis on sewer surcharge programs and practices * Estimated cost of monitoring - estimates of incremental capital and operating costs - economic and financial implications for each sector and its firms and plants in domestic and international contexts **Help develop cost-effective regulations and identify potential impacts and problems.**
Monitoring Regulation	* Generic abatement technologies - determine costs of achieving various levels of controls - derive least cost programs to achieve specific effluent reductions

	* Estimated cost of abatement - micro economic and sectoral impacts of various effluent limit scenarios - assessment of implications
	* Actual costs of monitoring - assessment of implications of accumulated cost of MISA monitoring program
Effluent Limits Regulation	* Benefit and Risk Assessments - identify, quantify and value potential benefits and risk reductions for particularly contentious sectors - using economic models, determine the net benefits of MISA to Ontario, including the environmental protection industry **Provide input to other environmental policy initiatives.**

2.2 Concept of "Economically Achievable"

Information and insights from the economic assessments will help to judge what levels of abatement and expenditure are "economically achievable" under BATEA. It is not a simple matter, however, to define "economically achievable". The term was first mentioned in the United States where the Clean Water Act,1977 uses the term, but does not provide a clear definition. Literature from the U.S. Environmental Protection Agency (USEPA), tends to define economically achievable by example.

When the USEPA instituted effluent limit regulations, it linked the average of the best existing performance of installed technologies in controlling conventional pollutants to, at minimum, the best economically achievable performance of plants with shared characteristics. USEPA criteria involved in determining what technologies are best available and what the performance efficiency should be, included (MOE[16]):

- costs of applying the control technology
- age of the process equipment and facilities in place
- processes employed
- process changes available
- engineering or other technical aspects
- non water quality environmental considerations, such as air pollution, solid waste disposal, and energy consumption

The primary determinant of BAT, according to USEPA, is effluent reduction at a "reasonable" level of cost. In essence, the USEPA approach involves using average cost as an indicator of whether a technology or group of technologies is "economically achievable". That is, by examining how many industries use a particular technology, at what cost, and at what level of success in controlling the release of pollutants, it can be concluded that a particular technology is available, and economic in the opinion of industry.

In preparation for promulgating their effluent limit regulations, the USEPA commissioned a series of economic studies for each industrial sector. Using a representative report on the Pulp and Paper sector in the United States (USEPA[18]), the general scope of the USEPA economic analysis is be summarized in Table 2.

The USEPA material makes it clear that several issues must be clarified when defining BATEA.

Table 2

USEPA Economic Impact Analysis

- Cost of compliance on the sector and individual firms
  - using production information and data on treatment costs, calculate cost of compliance and the distribution of unit costs
  - make forecasts of industry capacity expansion to calculate costs of compliance by product sector
  - estimate costs of compliance both for capital costs and total annual operating costs
- Demand/Supply analysis for each market (product) sector
  - micro economic analysis
  - effects of increased costs on market factors such as prices and output
- Capital Availability
  - examine the ability of the industry to finance investments in new capacity both with and without pollution controls
- Closure Analysis
  - projected number (%) of closures
  - associated employment impacts
- Community impacts
  - indirect effects of any closures on employment and earnings
- Balance of Trade impacts
  - effect of increased prices on international competitiveness of products with significant amounts of exports and imports

---

First, technologies need to be evaluated and ranked on the basis of their ability to recover or reduce problematic pollutants. Thus, data on the removal efficiencies of different pollutants for each technology must be obtained. Removal efficiency is a necessary, but not a sufficient, criterion for defining BAT. The greater the removal efficiency, the more likely that a technology will be "best available".

However, different technologies can have similar removal efficiencies. Another criterion must be introduced to choose among technologies with similar removal capabilities. The second criterion is cost-effectiveness. Best available technology can, therefore, be defined as the technology that achieves the greatest removal of particular pollutants at the lowest cost per unit removed. Consequently, information on the capital and operating costs of each technology or combination of technologies must be collected.

Studies have shown that different combinations of technologies can be identified that will achieve successively higher degrees of pollutant removal at least-cost until a maximum technically feasible limit is reached. The question then is what degree of removal (at least-cost), along the potential continuum, is "economically achievable" for a particular firm or industrial sector.

Once the cost and removal efficiency information is assembled into graphs known as least-cost abatement tables or cost functions, financial performance data for affected firms or industrial sectors can be compared to determine the relevant economic impacts and the behaviourial responses. Criteria must be defined to judge whether the costs are "economically achievable" or not.

As discussed earlier, the USEPA literature is vague on specific criteria that have been used in their regulatory programs. Indeed, it is likely that there is no single economic or financial criterion that will unequivocally show that a particular level of pollutant removal and cost is "economically achievable".

Nevertheless, these analyses will help ensure that the monitoring and abatement efforts are cost-effective. They serve to identify firms which will be most heavily burdened, and unproductive disputes about the costs and their implications can be minimized if not avoided entirely.

The Policy and Planning Branch of MOE is continuing to review the U.S. experience, and to evaluate the definitions of "economically achievable" in order to support the aim of MISA, which is to achieve the virtual elimination of toxics in the most cost-effective and equitable manner possible.

The next two sections deal with work done to-date, and presents results of economic analytical work.

3.0 INDUSTRY PROFILES

Industry profiles are intended to provide an economic database of the sectors and firms which will be subject to MISA and other environmental policy initiatives such as the proposed revisions to Ontario air quality requirements (Regulation 308) and waste management programs (Regulation 309). The Policy and Planning Branch of MOE developed a detailed Terms of Reference for industry profiles, which were to be carried out for each sector by consultants. Requirements specified in this Terms of Reference are described in Appendix B. This section details the methodology and goals of these profiles, as well as present the main findings and results of the assessments.

3.1 Methodology

The industrial profiles were intended to provide the Ministry with background information about each industry which could be used in the Joint Technical Committee deliberations. The consultants were told to limit their investigations to publicly available data. Suggested data sources included a literature search, company financial reports, and Statistics Canada. Other sources considered were trade associations, banks, brokerage houses, trade journals, academic publications, and government documents and agencies.

The SIC, or standard industrial classification codes of some firms did not always fit neatly into either Statistics Canada data or into the MISA-specified industrial groupings. For example, Courtaulds Canada, part of the Organic Chemical Manufacturing sector, is classified as a textile manufacturer. Therefore, while Statistics Canada industry data used for organic chemicals were not directly related to this firm, it was assumed that trends and characteristics of the broadly defined Statistics Canada "chemical sector" would be applicable to firms outside the applicable SIC codes.

Table 3 lists the financial information considered necessary to assess the financial state of each sector and its constituent firms.

Table 3

Financial Indicators

Financial indicators calculated for each firm for the last five years:

net income
sales
total expenses
after - tax profits (losses)
cash flow
working capital
total debt (long term and short term)
capital expenditures
total dividends (preferred and common)
shareholders' equity (preferred plus common)

Financial ratios calculated for the sector and each firm for the last five years:

working capital ratio (or current ratio)
"quick" asset ratio
debt to equity ratio
interest coverage ratio
net (after-tax) return on invested capital
rate of return on total assets

In order to obtain a comprehensive picture of each industry, information about financial and economic performance internationally, nationally, for Ontario, and specifically for those Ontario plants subject to MISA was assembled.

In general, plant-specific data and information about non-public companies are not available. If firms are components of larger parent corporations, such as Esso Chemical to Imperial Oil, financial statements of the parent were supplemented with data on appropriate subdivisions of the larger firm. Firms have been invited to provide the Ministry with disaggregated, plant-specific financial data if they feel that consolidated statistics do not accurately reflect the condition of their operations.

Data tables were provided to the Ministry by the consultants on a PC Lotus 1-2-3 format to facilitate future updates and data manipulation. This feature is essential, since many of the original reports submitted by the consultants contained 1985 or 1986 data, which then had to be updated by Socio-Economic Section staff. Staff economists will continue to update the profiles in terms of any changes in market conditions and financial indicators. It should be noted that the profile for the first industrial sector, Petroleum Refining, has not been formally updated beyond 1985 statistics, and any discussion in the text of this paper refers to information found in recent company financial reports.

3.2 Sector Profiles

This section discusses the findings and results of two sector profiles. The three major areas of interest are highlighted: the definition of each sector, a discussion and assessment of market structure information including major products and competitive positions, and a review of financial and economic trends and forecasts.

The first sector, the Petroleum Refining industry, had its Monitoring Regulation promulgated June 7, 1988. The second, the Organic Chemical Manufacturing (OCM) sector had its Draft Monitoring Regulation issued for public review in mid-October. All the other industrial profiles which have been prepared are referenced at the end of the paper, and analytical work is currently underway for all of the remaining sectors.

3.2.1 Definition of the Industrial Sector

The first step in understanding an industrial sector is to define the sector in terms of the firms that comprise it and to identify the key products that are involved.

For some sectors, such as Petroleum Refining or Metal Mining, activities are clearly defined and fit well into traditional statistical data sources. However, for other MISA-defined industrial sectors, there is no clear definition of the sector. For example, firms in the "organic chemical manufacturing" sector range from large multinationals to small local specialty operations. The products of the firms vary widely. Some sectors are grouped together more for the sake of the MISA regulations than for any statistical logic.

Petroleum Refining Sector

Refineries process crude oil to make a wide range of products with the petroleum refining sector as one component of the vertically integrated multinational oil industry. Most major international oil companies are vertically integrated in that they operate in each level of the business, including crude oil production, crude oil transportation, refining, wholesale distribution and sales, and finally, retail sales.

The Canadian petroleum refining sector consists of 28 refineries which are owned by 12 different companies. There are seven refineries in Ontario which are owned by six companies: Esso Petroleum (Imperial Oil), Petro-Canada, Petrosar, Shell Canada Products, Suncor, and Texaco Canada. All seven of these refineries are subject to the MISA monitoring regulations.

As of 1985, Petro-Canada, Esso Petroleum and Shell Canada accounted for 56% of total Canadian petroleum refining capacity. The seven Ontario refineries accounted for 31% of total Canadian crude oil processing capacity (MOE[11]).

Within Ontario, five of the refineries are located in the Sarnia area, while two are in Oakville, near Toronto.

OCM Sector

Firms involved in the OCM industry may be disaggregated into subsectors which manufacture and/or process petrochemicals, those which make organic and specialty chemicals, and those which produce finished or end-use chemical products. Most organic chemical products are derived from crude oil and natural gas while a small proportion of products can be derived from animal fats, vegetable oils and other natural materials.

In Canada, about one third of available crude oil and natural gas quantities are used to produce all the petrochemical products that are used domestically or exported. These "feedstocks" are broken down (cracked) in petrochemical plants and then recombined (polymerized) to form new products such as plastics, paints, polyesters and fibres.

About 70 firms operate 150 chemical production plants in Canada. Of these, about 60 plants, or 40%, are located in Ontario. The next largest centres of activity are Quebec and Alberta. In Ontario, 19 of these plants, owned by 17 firms, are direct effluent dischargers and will be subject to MISA regulations.

3.2.2 Market Structure

An understanding of the market structure for each industrial sector aids in the assessment of the financial and economic impacts of regulatory initiatives such as MISA. Firms which sell primarily to highly competitive markets where there is a high potential for product substitution by consumers will find it difficult to pass on certain costs in the form of higher product prices. At the same time, firms that are owned by large foreign controlled multinationals may be able to absorb increased costs more easily than single plant, locally owned firms.

Other factors such as the nature of the products produced, the technologies employed, the number of people employed and the location of other plants are important in the development and assessment of cost-effective and equitable environmental protection policies.

Petroleum Refining Sector

Four companies account for just over 61% of the value of shipments of petroleum products in Canada, while eight firms account for 86% of the total value of shipments. In Ontario, the four largest companies controlled 75% of the total refinery capacity during 1984 (MOE[11]).

Such statistics have led some authorities to characterize the oil industry as an oligopoly. In theory, this means that there are so few sellers in the relevant market that individual producers must take account of other firms' actions in making business decisions. In an oligopolistic situation, competition among major companies may be limited if firms possess market power as a result of this market structure and if demand for products is inelastic. Companies in an oligopolistic market would also be better able to pass cost increases along as higher product prices.

However, extensive investigations by Canadian government agencies found no evidence of past collusion or pricing agreements in the oil industry (WoodsGordon[20]). These studies also identified factors which limited to ability of Canadian oil companies to control market pricing. Moreover, the dismantling of the National Energy Program (NEP) in 1985 and the subsequent deregulation of oil prices in Canada means that offshore producers can now export petroleum products freely into Canada and Ontario, thus increasing competitive pressures on Ontario refineries.

Nearly 50% of Ontario's refinery production is transportation fuels (gasoline, diesel and aviation fuels). These fuels make up about 60% of the national petroleum output.

The value of Ontario shipments of petroleum products amounted to 6% of the provincial Gross Domestic Product (GDP) during 1985. The fact that the value of shipments has been rising steadily in the face of fluctuating and even declining production means that product prices (including taxes) have, on average, been rising steadily since 1977. Petroleum specialists have estimated that demand for gasoline, like cigarettes, is inelastic with respect to price in the short run (eg. 6 months to one year). This means that a price increase will not engender a proportionate decrease in the amount of product consumed. From the industry's point of view, if demand for a product is price inelastic, prices can be increased without incurring substantial reductions in sales and revenues.

Over the longer run (eg. 2-5 years), demand may be more price elastic because consumers have opportunities to adjust their consumption patterns, find substitutes or produce more efficient fuel-using equipment. If these adjustments are made, and other conditions remain constant, firms could experience absolute reductions in consumption, revenues, and depending on cost conditions, a possible reduction in profits. It has been estimated that the long-term demand for light fuel oils is relatively price elastic.

OCM Sector

Firms within the petrochemical subsector tend to be large multinationals, the majority of which are foreign-owned. Two large firms in this sector, Polysar and Dow Canada, are Canadian-owned.

Canadian organic chemical firms sold over $5.0 billion worth of products in 1986, up over 2% from the previous year (MOE[12]). Of this amount, 62% were sold in Canada. The primary petrochemicals subsector produces benzene, ethylene and butadiene, among other products, which are in turn processed further to make intermediate petrochemicals that are used in other manufacturing processes. Consumer end-products of the organic chemical industry include plastics, carpeting, synthetic materials, furniture parts, and paints.

The organic chemical industry employed just over 17,000 people in Canada during 1986. While this is not large in terms of direct employment, the industry tends to generate substantial indirect employment at subsequent stages of the manufacture of derivatives.

Firms in the Canadian and Ontario OCM sector can be generally described to be:

- net exporters of bulk petrochemicals and net importers of organic and specialty chemicals. Their major trading partner is the United States, which accounts for over 60% of Canada's exports and over 90% of major imported chemicals.
- price takers, with benchmark prices set internationally, primarily by American producers. These American producers in turn must take into account the rising influence of newer producers and consumers in the Pacific Rim, Middle East, and Europe. In the context of the world market, Canada is not yet large enough to influence trends. The Canadian OCM sector is, however, growing in importance.
- capital intensive, which tends to limit exit as well as entry into the industry. The large investment needed to capture fully economies of scale represents a barrier to firms who wish to enter the market in boom times, and to firms who wish to exit in poor times.

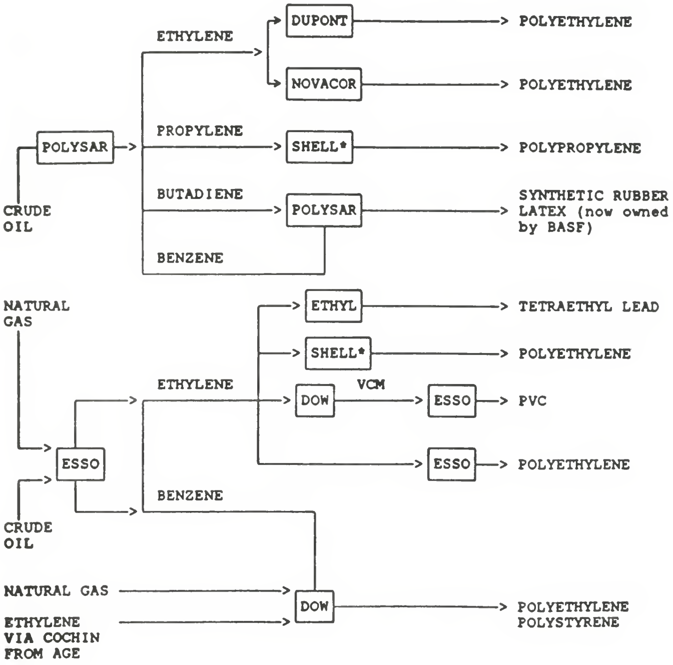
Canada has tried to protect its chemical industry with tariff and non-tariff barriers, with rates generally increasing as the product is upgraded. Such tariffs will be eliminated under the terms of the Canada-U.S. Free Trade Agreement.

Within Ontario, the primary and intermediate petrochemical producers tends to be oligopolistic (few sellers) and physically interdependent. This means that these firms tend to locate close together, as in Sarnia's "chemical valley", and sell products to each other. Figure 1 illustrates this feature.

In a global context, primary and intermediate bulk chemicals are sold in competitive markets. The OCM sector is very dependent

Figure 1

SIMPLIFIED FLOWCHART OF
ONTARIO PETROCHEMICAL INDUSTRY INTERDEPENDENCE
IN SARNIA, ONTARIO



Source: MOE (12)

on the current business cycle, which is now at a peak. The 1987/88 demand for petrochemicals is currently growing, causing many firms to experience profits in their chemicals divisions. This represents a recovery from the recession of the early 1980's which caused depressed demand, falling prices, and losses by a number of firms.

3.2.3 Trends and Forecasts

It is not sufficient to view merely an annual "snapshot" of data of any given industry or firm. The current year may be an anomaly, or a transitional period. If these sectors were examined during the recessionary period, the assessments and predictions would be far different than at present. It is therefore important to get a sense of past trends and influences. Since the MISA and other regulatory programs come into force over a period of time, the sector profiles also attempted to look into the future and forecast accordingly.

Petroleum Refining Sector

The Canadian Petroleum industry has undergone significant "downsizing" in light of declining demand for refinery products. Remaining refineries tend to be larger and more efficient.

In 1985, the Canadian oil industry was deregulated and crude oil prices in Canada were determined by world prices. Shortly after the dismantling of the National Energy Program, world crude oil prices fell 58% between December 1985 and July 1986. The equivalent net effect on the retail price of gasoline would have been a 28% drop in price as of January 1986.

Figures 2a and 2b show that when crude oil prices and retail gasoline prices were falling, the proportion of the retail price going to refineries, dealers, and taxes increased. Lower crude oil prices should, therefore, enhance the financial performance of the

Figure 2a

RETAIL GASOLINE PRICE STRUCTURE
TORONTO REGION, JANUARY 1986
(PRICE = 50.7 CENTS PER LITRE)

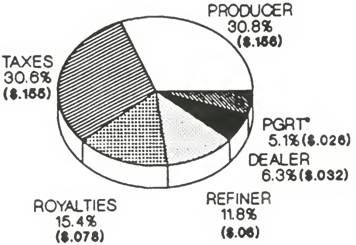
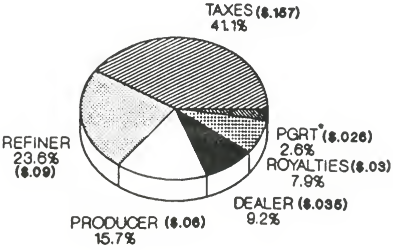


Figure 2b

RETAIL GASOLINE PRICE STRUCTURE
TORONTO REGION, APRIL 1986
(PRICE = 36.2 CENTS PER LITRE)



Source: MOE (11)

refining sector of the oil business since crude oil feedstock is the major operating cost in the refinery. In fact, falling crude oil prices resulted in higher returns to the refining component of the business (MOE[11], WoodsGordon[20]).

Figures 3 and 4 show comparative standings for five oil companies in Ontario for two selected financial indicators. After-tax profit, or net income, is the surplus remaining after all current expenses, interest, charges, and taxes are paid. This is a measure of the long term financial health of a company and an industry. Internal cash flow is defined as net income plus depreciation and is an indication of the ability to pay current expenses, declare dividends and finance expansion. A company which shows little or no after-tax profit can, for a short time, still meet its debts and obligations if cash flow from other sources is adequate. The larger the cash flow, the better.

Figure 3 shows that after-tax profits, or net income, have been increasing. Company annual reports further indicate that 1987 is a boom year, with many firms recording profits at much higher levels than in previous years. Figure 4 indicates that the cash flows of these firms continue to be positive.

Slow growth in product demand has prompted the contraction of refinery capacity and employment in recent years by means of closures and "rationalization" of facilities. Therefore, despite the healthy financial results recorded in 1987, long term growth is expected to be modest for the petroleum refining sector. Large capital investments have been made at Ontario refineries to keep these facilities competitive. There also continues to be uncertainty about the future in terms of oil prices and competitive pressures (MOE[11]).

Figure 3

AFTER-TAX PROFIT
(BEFORE EXTRAORDINARY ITEMS)
PETROLEUM SECTOR, 1981-1985

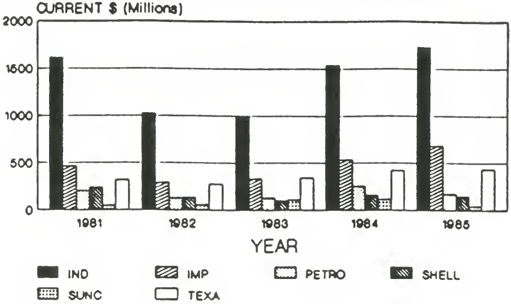
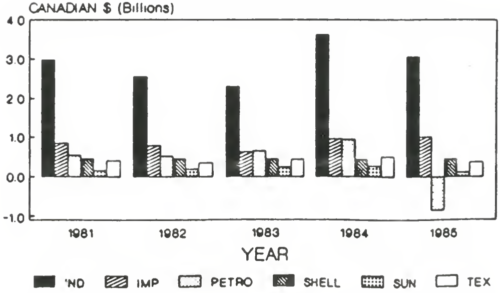


Figure 4

CASH FLOW
PETROLEUM SECTOR, 1981-1985



Source: MOE (11)

OCM Sector

Canadian producers experienced profits during the late 1970's due to positive economic growth and government initiatives such as the National Energy Program, which held the price of domestic oil and gas feedstocks below world prices. When Canadian oil prices were finally allowed to match world oil prices in the 1980's, the latter began to soften and fall. Feedstock costs for chemical producers were pushed up in the face of continued slack demand for their output. At the same time, producers carried the high capital costs of earlier expansions.

Currently, OCM sector companies are planning expansions and are experiencing record profits. For example, Polysar has recently restarted a mothballed styrene plant in Sarnia because of the low supply and rising demand for styrene, which is a building block in the manufacture of plastics and synthetic rubber. Polysar expects the styrene plant to add at least $18 million to company petrochemical earnings (MOE[12]).

A review of company performance statistics available for those firms whose plants are subject to MISA requirements reveals little homogeneity and large variation. In addition to the problem of having at best aggregated data, the financial performance indicators of the MISA designated OCM companies do not necessarily represent the organic chemical industry because some of the firms in the MISA sector make and sell products in a different industrial sector.

Figure 5 shows after-tax profit (net income) trends for selected OCM firms that are subject to MISA monitoring regulations. There has been a strong recovery in 1987, with most companies returning to or exceeding pre-recession profit levels. It can be seen in Figure 6 that most companies are showing steady improvement in their cash flow positions.

Figure 5

NET INCOME (LOSS)
OCM SECTOR
1983 - 1987

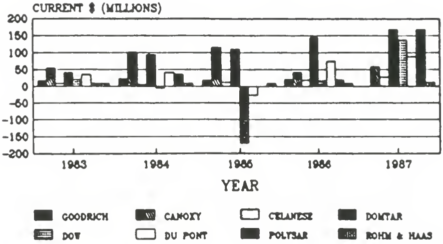
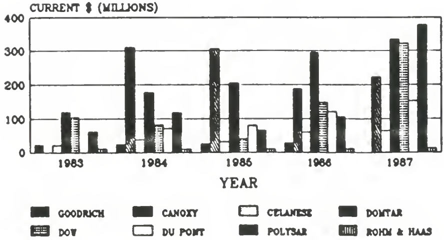


Figure 6

INTERNAL CASH FLOW
OCM SECTOR
1983 - 1987



Source: MOE (12)

It is expected that rising demand for chemical products, combined with relatively lower feedstock prices, tight capacity in the petrochemical sector, and a weak Canadian dollar in relation to U.S. currency will continue to boost Canadian and, in particular, Ontario's organic chemical manufacturing sector performance statistics.

A review of company annual reports indicates that their chemicals divisions are profitable and expanding capacity. For example, the B.F.Goodrich plant in Ontario subject to the MISA monitoring requirements produces PVC (polyvinyl chloride) plastics. Its parent company, B.F.Goodrich, has a separate PVC and Intermediates Division which had sales revenues of $866 million in 1985 growing to $1.1 billion in 1987. Operating income for this division grew from a loss of $185 million in 1985 to a profit of $144 million in 1987. Total U.S. demand for PVC grew 7.3% in 1987. In fact, because of the high demand for PVC as a substitute for plastic and other non-plastic materials, many producers, including B.F.Goodrich, were unable to maintain adequate supply (BFG Annual Report 1987 in MOE[12]). Other firms in this MISA sector involved in the production of PVC are expected to do well.

The Canada-U.S. Free Trade Agreement will likely benefit the petrochemical sector because these producers export most of their output to U.S. customers. The organic and specialty chemical sector, which is a net importer, will probably benefit through the elimination of Canadian tariffs on U.S. imports, but could face greater competition from other sellers seeking to expand their markets. At this time, the implications of the Free Trade Agreement on individual plants is unknown.

Section 4.2 discusses the impacts of the estimated MISA monitoring costs on the OCM sector firms

4.0 ESTIMATED COST OF MONITORING

The monitoring requirements are the first step towards abatement regulations under the MISA program. The monitoring regulations will be in effect for a 12-month period for each industrial sector. Data from the specified monitoring activities will be used in the development of specific limits regulations.

The economic assessments present estimates of the incremental costs associated with the sector monitoring regulation. Impacts of these costs on certain financial indicators of the sector, and firms and plants within the sector, are also examined.

Section 4.1 outlines the methodology of these economic studies, and discusses the technical background for these estimates.

4.1 Methodology

The monitoring requirements translate into 6 monitoring functions or activities which each eligible plant must carry out. These monitoring functions include sampling (including transportation to laboratory facilities), characterization analyses, routine analyses, toxicity testing, flow measurement and reporting. Capital and operating costs are estimated for each of these activities as they apply at each plant.

Normally, operating costs are expressed as recurring annual expenses. However, the MISA monitoring regulations are in force for only a 12-month period so that all operating and capital costs will be incurred during that period.

Capital costs include costs incurred for equipment and installations which can be used longer than the one-year tenure of the regulation. These capital items would normally be depreciated over a period of several years. Consequently, only a portion of the capital expenditure would be counted as an expense for tax purposed during the 12-month period of the regulation. Current depreciation rules permit a 3-year write-off for pollution control-related items at a rate of 25%, 50%, and 25%.

However, when assessing the impacts of the monitoring costs on plant and company financial performance, total incremental capital costs, rather than the depreciated values, were used in order to provide a conservative, maximum impact scenario.

Steps involved in cost estimation include the determination of what activities and resource inputs are required to implement each monitoring function, and the stated use of simplifying assumptions where necessary.

Cost estimates are based on specifications in the sector-specific monitoring regulations.

Single-valued or point cost estimates for monitoring activities are presented, but should be treated with some caution because:

- inputs required for different types of monitoring functions are often uncertain; and
- there is some flexibility as to how individual plants might actually implement some of the monitoring requirements.

The monitoring regulations for each sector are not identical. The Petroleum Refining sector has a common set of contaminants that each refinery must test for at the same frequency. This was done because refineries are fairly homogeneous production plants. Because the Organic Chemical Manufacturing (OCM) sector plants vary widely in the processes they use and the pollutants they discharge, plant and pipe-specific (ie. final discharge point) monitoring requirements are specified. This approach is potentially cost-effective because each plant in the OCM sector will only have to test for pollutants that are actually found in their particular wastes.

Ranges of costs for some monitoring functions were included in the analyses where possible. Ranges in costs are due to uncertainties about capital costs and about the prices that will have to be paid for the analytical tests.

The MISA monitoring program is directed at all potential point sources of pollution entering surface watercourses, including treated or untreated process effluent, cooling water, stormwater runoff, emergency overflows, waste disposal site drainage, and combinations of the above. In order to estimate the costs of monitoring these final discharge points, it is important to understand what they mean.

Process effluent, with or without treatment, are the primary concern of the MISA program since they contain the highest concentrations and loadings of contaminants. The monitoring strategies are most comprehensive and rigorous for these waste streams. **Cooling water** is used to cool industrial process units and can be contaminated by leaks. In addition, chemicals are added to control slime growths and prevent corrosion. **Stormwater runoff** following rainfall or snowmelt events can carry contaminants from processing or storage areas. Storm drainage channels are often the route for leaks and spills to gain access to surface waters.

Waste disposal site drainage exists on-site in some industries that treat or dispose of solid waste on their own property. **Emergency overflow** routes often exist for untreated or partially treated wastewater. These are used only when treatment processes or equipment breaks down. **Combined effluent** are streams that are mixed with process effluent and possibly other wastewaters.

Finally **intake water** locations are points where water is drawn into the system. Intake water is not required to be sampled in the MISA program. Contaminants can be found in intake water as a result of polluted sediments from historical releases, upstream contamination, and recirculation of discharges from the plant site.

Figure 7 illustrates these different types of effluent streams for a typical industrial plant site.

The General Effluent Monitoring Regulation specifies requirements for the six major monitoring activities, which each wastewater discharger must implement to various degrees and levels of effort.

4.2 Estimated Costs of Monitoring and Their Implications

As noted earlier, two of the nine MISA designated industrial sectors have their sector-specific monitoring regulations issued at the time of writing. Accordingly, monitoring cost estimates and impacts for these two sectors have been completed thus far.

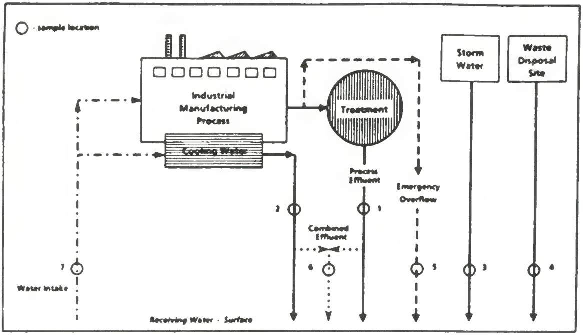
Petroleum Refining Sector

The total incremental capital and operating costs that could be incurred to comply with the monitoring regulations for this sector amount to \$3.5 million with a range of \$3.0 million to \$4.3 million (MOE[8]).

The point estimate of the total capital cost is \$1.6 million. Because of the uncertainties associated with these estimates, the actual total capital expenditures could vary by +/-30% or between \$1 million and \$2 million. Spokesmen for the refineries have emphasized that they intend to install automatic samplers and flow measurement facilities at virtually all of their sampling points and intake water locations in order to achieve the accuracy requirements of the regulations and to reduce long term, recurring labour costs that are associated with other methods of sampling and

Figure 7

Typical Industrial Plant Site Monitoring Locations



Source: MOE (14)

flow measurement.

The total operating costs for all monitoring activities, including contingencies, could amount to over $1.9 million. Oil firms indicate that these estimates could vary by +/- 15% or $1.6 million to $2.2 million.

The oil companies intend to spend more than what may be strictly required to comply with the monitoring regulations. If production efficiencies are not realized from these monitoring expenditures, then the extra costs will serve only to reduce profit and return on investment to refining assets.

There are no published disaggregated financial or production data on Ontario refineries. There are, however, statistics on the petroleum products segments for each company, except Petrosar. The financial data utilized for the five other firms are a consolidation of each company's petroleum product operations across Canada, not just the Ontario facilities.

The monitoring capital cost estimate for each refinery was computed as the percent of the lowest annual capital expenditure between 1981 and 1985. This quotient indicates how much of the firm's petroleum product segment capital budget would have been required for monitoring in that year.

Another measure of financial impact is the percentage by which the extra operating costs would reduce each company's after-tax profits (or increase losses) for the petroleum products segment of the company's business. The monitoring cost estimates were compared with the after-tax net earnings (net profits) for the segments over five years (1981 -1985) and against the lowest positive after-tax profit achieved during this same period.

Table 4 summarizes these comparisons. The results show that the point estimates of monitoring cost estimates account for less than 1% of total capital expenditures and net-earnings for four firms. Although small in comparison to the consolidated earnings of these multinational corporations, these extra costs can nevertheless have a significant effect on a segment of the firm's business and the plant to which the costs are assigned.

The cost estimates are largest in relation to the capital expenditures and after-tax earnings of Suncor, which suffered losses in recent years. Texaco Canada also incurred significant losses in 1983 and 1984. Monitoring costs would have increased these losses by about 1%.

The impacts of both capital and operating costs on a firm are mitigated by the tax system. Because all or a part of these costs can be deducted from taxable profits, the federal and provincial governments will share some of the costs in terms of reduced tax revenue.

Profit levels for the industry have been improving, with 1987 being a particularly profitable year. It can be concluded therefore, that, if the petroleum companies perform as well (or no more poorly) as they did over the past 5-6 years, the incremental costs resulting from the MISA monitoring requirements will not significantly impact the financial performance of the firms within the Petroleum Refining sector.

OCM Sector

The incremental capital costs of complying with the monitoring regulations for this sector are estimated to be about $2.2 million. These costs are subject to varying degrees of uncertainty, and representatives of the firms who provided these estimates indicate that this uncertainty could vary from +/- 5% to +/- 25%. Using an

Table 4

FINANCIAL IMPACTS OF ESTIMATED MONITORING COSTS ON THE CONSOLIDATED PETROLEUM PRODUCTS SEGMENT OF PETROLEUM COMPANIES

Company	Lowest Annual Capital Expenditure since 1981 for Petroleum Products Segments ($ Millions)	Point Estimate Capital Expenditure for Monitoring as a % of Total Capital Expenditure (%)	After-Tax Earnings (Loss) between 1981 and 1985		Total Operating Costs (with Contingencies) as a % of After-Tax Earnings (Loss)	
			Total Earnings for 5 Years ($ Million)	Lowest Positive Earnings during the period ($ Million)	Total for 5 years (%)	Lowest Positive Earnings (%)
Esso	129 (1984)	0.30	776	61 (1983)	0.04	0.5
Petro-Canada	80 (1981)	0.16	1,033	88 (1982)	0.06	0.7
Shell Canada	40 (1985)	0.74	349	23 (1983)	0.08	1.4
Suncor	28 (1985)	1.06	64	1 (1984)	0.5	32.9
Texaco Canada*	59 (1983)	0.06	(25)	39 (1985)	(1.0)	0.6

* Capital expenditure and earnings data only available for 1983, 1984 and 1985

Source: MOE (8)

average uncertainty measure of +/- 15%, the total capital costs of the regulation requirements could range from $1.9 million to $2.5 million (MOE[15]).

The point estimate of the incremental operating costs of compliance is $6.7 million. These expenses will also be incurred over the 12-month period of the monitoring regulation.

The estimated total incremental capital and operating costs based on the monitoring functions in the OCM effluent-specific schedules for the nineteen plants in this sector are:

Sampling	$2.2 million
Characterization	$0.6 million
Routine Monitoring	$4.4 million
Toxicity Testing	$0.3 million
Flow Measurement	$0.9 million
Reporting	$0.5 million
TOTAL	$8.9 million

In order to illustrate the cost-effectiveness of the monitoring requirements, estimates of the routine analyses costs under an alternative set of assumptions were developed. As noted, the OCM sector involves plant and stream-specific requirements. If, however, OCM firms were required to adhere to a single, across-the-board set of monitoring requirements as does the Petroleum sector, the costs of monitoring would be vastly different.

This "stringent" scenario resulted in a point-estimate of routine analyses costs totalling $16.5 million, versus the $4.4 million under the OCM regulation requirements. This difference of $12.2 million represents a cost saving for the OCM sector, and is a measure of the cost-effectiveness of the pipe-specific approach used in this sector. The Ministry has been cognizant of the potential financial demands of the MISA requirements, and has incorporated such considerations in the development of the monitoring regulations without a significant loss of technical data.

The impact of the monitoring costs of MISA on the Canadian OCM sector as a whole will likely be negligible. The estimated total capital cost of monitoring, $2.2 million, represents only 0.4% of the average annual capital expenditures recorded for the Canadian firms in this sector by the Canadian Chemical Producers' Association (CCPA) between 1982 and 1986 (MOE[15]). For the lowest annual level of capital expenditures during that period, the point-estimate for monitoring would be still under 1% of the average annual capital expenditure levels.

Employment impacts would be neutral to slightly positive, since the monitoring requirements might stimulate job opportunities for personnel to collect and analyze samples. Further employment opportunities will likely be generated in the form of consultants, analytical laboratories, and equipment manufactures.

The total estimated incremental costs of monitoring would reduce average (1982 - 1986) total pre-tax profits of the OCM sector about 5.8% (MOE[15]).

Given this small effect, monitoring costs are not expected to adversely affect the international competitiveness of the firms in the OCM sector.

Demand, sales, and earnings for the organic chemical industry are currently buoyant. Firms are planning to increase capacity to take advantage of relatively lower feedstock prices and rising demand for chemical products. Monitoring costs will, therefore, have a much smaller impact over the next 12 to 24 months than they would if they have been incurred in previous years.

Because plant-specific data are not generally available, the financial effects of monitoring must be assessed against consolidated company data. It is assumed that all of the firms in this sector operate in a competitive market and will not be able to pass cost increases on as higher prices. This assumption may be overly conservative for some firms which produce specialty chemicals and which have enjoyed tariff protection. Costs incurred over the 12-month monitoring period will therefore be reflected in reduced after-tax profits.

Table 5 shows how each plant's monitoring costs compare with capital expenditure and net profit trends for each company.

Estimated capital costs of monitoring represent less than 1% of company average annual capital expenditures. Rohm and Haas is an exception, with the capital costs of monitoring representing 3.3% of average annual capital expenditures.

The impact on average after-tax profit is also relatively low, with representative percentages of operating costs of monitoring ranging from 0.1% to 2.9%.

All the firms for which data are available have sufficiently large working capital balances to cover the monitoring costs. Firms which do not have sufficient working capital may need to seek external financing.

It can be concluded, therefore, that the imposition of monitoring costs will not pose an undue financial or economic burden on those firms within the OCM sector for which financial data were available.

Table 5

Financial Impact of Monitoring Costs - OCM Sector

Company/Plant	Capital Expenditures			After-Tax Earnings		
	Average 1983-1987 ($ Millions)	% Represented by Point Estimate Capital Cost of Monitoring		Average 1983-1987 ($ Millions)	% Represented by Point Estimate Capital Cost of Monitoring	
		Average	Lowest		Average	Lowest
B.F. Goodrich Canada Inc.	19.7	0	0	19.7	0.6	0.7
BTL Industries Inc.	N/A			N/A		
Borg-Warner (Canada) Limited	N/A			N/A		
CanadianOxy Chemicals Ltd.	130.0	0.02	0.1	68.1	0.1	0.2
Celanese Canada Inc.	22.7	0.3	0.5	8.2	2.5	(3.7)
Cornwall Chemicals Limited	*			*		
Courtaulds Fibres Canada (formerly Courtaulds North America Inc.)	*			*		
Courtaulds Films (formerly BCL Canada Inc.)	*			*		
Domtar Inc.	298.6	0.02	0.1	110.1	0.2	0.5
Dow Chemical Canada Inc.	81.0	0.7	1.0	0.4	**	(1.0)
(DuPont Canada Inc. - Corunna)						
(DuPont Canada Inc. - Kingston)	60.0	0.4	1.1	42.7	1.8	(2.9)
(DuPont Canada Inc. - Maitland)						
Esso Chemical Canada (Imperial Oil)	928.0	.03	.04	497.6	0.1	0.1
Chemicals Division	41.4	0.6	0.1	13.2	2.6	(3.4)
Ethyl Canada Inc. (Parent Company)	110.0	0	0	145.2	0.3	0.4
Chemicals Division	65.8	0	0	162.9	0.3	0.4
Novacor Chemicals Ltd.	263.1	0.01	0.02	87.1	0.1	(0.1)
Polysar Limited	217.8	0.3	0.3	46.2	2.9	**
Rohm and Haas Canada Inc.	1.9	3.3	4.7	9.4	1.3	1.4
Uniroyal Chemical Ltd.	N/A			N/A		

N/A No data available

* Insufficient data available

** Greater than 100%

Source: MOE (15)

4.2.1 Comparison of the Petroleum and OCM Sectors

Table 6 presents a comparison of the costs by monitoring function for each of the two sectors discussed in this paper.

Table 6

Comparison of Total Costs by Monitoring Function

($000's)

	Organic Chemicals	Petroleum Refining
Sampling	$ 2,248 (25.1%)	$ 792 (22.6%)
Characterization	607 (6.8%)	19 (0.5%)
Routine	4,379 (48.9%)	1,289 (36.7%)
Toxicity	312 (3.5%)	74 (2.1%)
Flow Measurement	897 (10.0%)	770 (21.9%)
Reporting	504 (5.6%)	567 (16.1%)
TOTAL	$ 8,947	$ 3,511

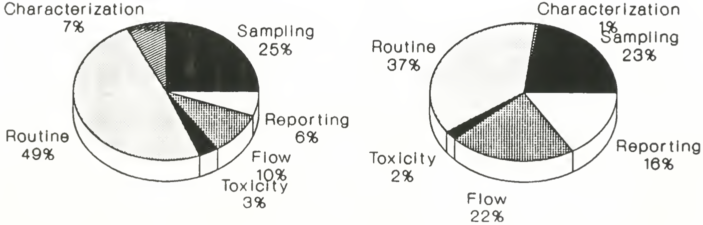
Figure 8 illustrates the different distribution of these costs among the monitoring functions in a pie chart format.

It is evident that routine analyses are the single highest cost component of monitoring for both sectors. It represents nearly half of the estimated costs for the OCM sector and over one-third of estimated costs for the petroleum refining sector. This reflects the basis of the monitoring regulations, which seek to accumulate data on the discharge of contaminants at several frequencies.

Another obvious difference between these two sectors is the variation between costs associated with flow measurement and reporting. The OCM sector cost estimates allocate fewer resources for these two activities because, presumably, the MISA subject firms in the OCM sector have in place adequate monitoring devices and personnel trained to take and measure samples. The petroleum

Figure 8

Costs by Monitoring Function



Organic Chemical (OCM) Sector

Petroleum Refining Sector

Source: MOE [8,15]

refining sector must invest more resources in providing an adequate level of measuring capabilities.

The total and median costs of monitoring for the first two industrial sectors subject to MISA are shown in Table 7.

Table 7

Comparison of Total Monitoring Costs

($000's)

	Organic Chemicals	Petroleum	TOTAL
Capital	$ 2,237	$ 1,575	$ 3,812
Operating	6,710	1,936	8,647
TOTAL	$ 8,947	$ 3,511	$12,459
Median	$ 243.5	$ 470	

The differences in total costs can be attributed to several factors, including:

- the difference in the number of plants in each sector. There are 19 plants in the organic chemical manufacturing sector, as opposed to 7 in the petroleum refining sector;
- the organic sector has monitoring requirements tailored to each individual plant and each individual final discharge point; and
- the number of streams to be monitored and the variety of production processes in the OCM sector are greater than the petroleum refining sector. Hence, contaminants are more complex in the organic sector, resulting in higher monitoring costs.

Future work involves the monitoring of actual costs incurred by each firm, as discussed in Section 5.

5.0 FUTURE ANALYTICAL WORK

As of writing, only one sector, petroleum refining, has had its monitoring regulation promulgated. Work on the remaining sectors is ongoing, with the economic analytical portions proceeding concurrently.

Upcoming economic work will involve assembling the information and data needed to construct monitoring and abatement functions for specific establishments or firms. The cost functions can then be used to estimate the total costs of the specific monitoring and effluent limits regulations for each industrial and municipal sector.

Abatement technologies and costs will be gathered initially through a generic study which will collect information on available technologies, their compatibility with different industries, their process capabilities and efficiencies, their current degree of usage by industries, and their associated capital and operating costs.

The aim of this phase of economic work is to develop a least-cost abatement cost functions which can specify a set of technology combinations that achieve desired abatement objectives at the lowest cost possible given available technologies. There are likely to be different combinations of technologies that can achieve the same level of abatement, but at higher costs. The development of a cost function will identify the combination of technologies that will achieve specific levels of reduction at the lowest cost.

An "abatement cost function" shows different levels of final effluent that can be achieved at specific levels of cost. Such data can be shown in a tabular format, comparing "best available technologies" emission reduction standards to the present values of reducing discharges by given percentages.

A model has been developed by the Policy and Planning Branch, and is known as "WATAP" (Waste Treatment Analysis Program), which was presented to the Technology Transfer Conference in 1986 (Donnan[7]). This model can be used to generate abatement cost functions for individual plants, which can be combined to produce aggregate cost functions as well as estimates of the total costs of achieving specific effluent limit objectives or technology-based requirements.

Another study that is currently ongoing involves a review of comparative discharge and emission standards between Ontario and other jurisdictions. This study will assess the resulting financial and economic impact on firms who have been subject to legislated environmental standards in other jurisdictions, primarily the United States. It will also take a look at empirical enforcement and abatement activities.

6.0 CONCLUSIONS

Economic assessments are an integral part of the MISA and other Ministry environmental policy initiatives. For direct dischargers, initial results, based on two of the nine MISA designated industrial sectors specified, indicate that the total estimated incremental costs of monitoring are about $12.5 million. Financial and economic analyses indicate that these costs will not likely compromise the economic or financial viabilities of the sectors or the individual firms for which financial data were available.

Work is currently underway to:

- update the economic profiles prepared for each sector;
- estimate the incremental capital costs associate with the monitoring regulations for the remaining industrial sectors;

- assess the financial and economic implications of the estimated monitoring costs on the sectors and individual firms within each sector;
- look at generic abatement technologies and their associated costs;
- examine comparative discharge and compliance standards in other jurisdictions, and to assess the impacts and behaviour of firms in these jurisdictions; and
- assess the combined impact of MISA and other policy initiatives on all direct dischargers.

REFERENCES

1. A.R.A. Consultants, Economic Profile of Metal Mining Sectors, May 1987, **DRAFT**, Prepared for MOE.

2. A.R.A. Consultants, Sector Profiles: Petrochemical and Organic Chemical Industries in Ontario, May 1987, **DRAFT**, Prepared for MOE.

3. The Coopers & Lybrand Consulting Group, Industrial Profile: Ontario Iron and Steel Producers, November 1987, **DRAFT**, Prepared for MOE.

4. Deloitte Haskins & Sells, Industrial Minerals Sector Profile, June 1987, **DRAFT**, Prepared for MOE.

5. Deloitte Haskins & Sells, Metal Casting Industry Economic Profile, April 1988, **DRAFT**, Prepared for MOE.

6. M.M.Dillon Consulting Engineers, "Evaluation of Municipal Sewer Use Control Options" (Phases I and II), 1988, Prepared for MOE.

7. Donnan, J. et al, "Abatement Cost Functions - the Workhorse of Environmental Management", in Proceedings of 1986 Technololgy Transfer Conference, MOE 1986

8. Ontario Ministry of the Environment, "Cost Estimates and Implications of the 'Effluent Monitoring - General' and 'Effluent Monitoring - Petroleum Refining Sector' Regulations for Ontario's Petroleum Refineries", Policy and Planning Branch, July 1988

9. Ontario Ministry of the Environment, "Economic Information Needs and Assessments for Developing MISA Monitoring and Abatement Requirements", Policy and Planning Branch, March 1987

10. Ontario Ministry of the Environment, "The Economic and Financial Profile of the Ontario Electric Power Generation Industry", Policy and Planning Branch, February 1988, **DRAFT**

11. Ontario Ministry of the Environment, "The Economic and Financial Profile of the Petroleum Refining Sector - Summary Report", Policy and Planning Branch, August 1988

12. Ontario Ministry of the Environment, "Economic Profile of the Organic Chemical Manufacturing Sector - Summary Report", Policy and Planning Branch, September 1988, **DRAFT**

13. Ontario Ministry of the Environment, "The Effluent Monitoring Regulation for the Organic Chemical Manufacturing Sector", Water Resources Branch, 1988 **DRAFT**

14. Ontario Ministry of the Environment, "Effluent Monitoring Regulations for the Petroleum Refining Sector", July 1988

15. Ontario Ministry of the Environment, "Ontario's Organic Chemical Manufacturing Sector Monitoring Cost Estimates", Policy and Planning Branch, September 1988, **DRAFT**

16. Ontario Ministry of the Environment, "A Policy and Program Statement of the Government of Ontario on Controlling Municipal and Industrial Discharges into Surface Waters", (MISA "White Paper"), June 1988

17. Ontario Ministry of the Environment, "The Public Review of the MISA White Paper and the Ministry of the Envronment's Response To It", January 1987

18. United States Environmental Protection Agency, "Economic Impact Analysis of Proposed Effluent Limitations Guidelines, New Source Performance Standards and Pretreatment Standards for the **Pulp, Paper and Paperboard Mills"**, Point Source Category, Volume 1, December 1980

19. Woods Gordon Management Consultants, The Economic and Financial Profile of the Ontario Inorganic Chemicals Industry, August 1987, Prepared for MOE.

20. Woods Gordon Management Consultants, The Economic and Financial Profile of the Ontario Petroleum Refining Industry, 1987, Prepared for MOE.

21. Woods Gordon Management Consultants, The Economic and Financial Profile of the Ontario Pulp and Paper Sector, June 1987, **DRAFT**, Prepared for MOE.

APPENDIX A

SELECTED MISA INDUSTRIAL SECTORS AND FIRMS

PETROLEUM REFINING

Esso Petroleum Canada (Sarnia)
Petro-Canada Inc. (Clarkson)
Petro-Canada Inc. (Trafalgar)
Petrosar Limited (Corunna)
Shell Canada Products Limited (Sarnia)
Suncor Inc. (Sarnia)
Texaco Canada Inc. (Nanticoke)

ORGANIC CHEMICAL MANUFACTURING

B.F.Goodrich Canada Inc. (Thorold)
BTL Industries Inc. (Belleville)
Borg-Warner (Canada) Limited (Cobourg)
CanadianOxy Chemicals Ltd. (Fort Erie)
Celanese Canada Inc. (Kingston)
Cornwall Chemicals Limited (Cornwall)
Courtaulds Fibres Canada (Cornwall)
    (formerly Courtaulds North America Inc.)
Courtaulds Films (Cornwall)
    (formerly BCL Canada Inc.)
Domtar Inc. (Longford Mills)
Dow Chemical Canada Inc. (Sarnia)
DuPont Canada Inc. (Corunna)
DuPont Canada Inc. (Kingston)
DuPont Canada Inc. (Maitland)
Esso Chemical Canada (Sarnia)
Ethyl Canada Inc. (Corunna)
Novacor Chemicals Ltd. (Mooretown)
Polysar Limited (Sarnia)
Rohm and Haas Canada Inc. (Morrisburg)
Uniroyal Chemical Ltd. (Elmira)

APPENDIX B
INDUSTRIAL SECTOR PROFILES
TERMS OF REFERENCE

The Terms of Reference for each sector profile specified the following information requirements, which were assembled for each sector noted in Section 1:

Definition of the Industrial Sector

1. Identify the firms that comprise the sector nationally and within Ontario. List and locate the individual firms and plants relevant to the MISA program.
2. Define the key products and/or product categories for the sector and individual firms.

Market Structure Information

1. Compile statistical data on products, physical output, employment, sales revenues, input components and costs for the sector over the past 10 years, and present this information for both national and provincial aggregates.
2. Present indicators of the degree of competition (or lack of it) within the sector. Include measures of concentration, or market share, as well as the rate of entrance to and exit from the key product markets.
3. Note ownership patterns, such as the degree of foreign ownership, and the number of conglomerates versus single plant, locally owned firms.
4. Note types of market situations as they occur. For example, cases of monopolistic (single seller), monopsonistic (single buyer), oligopolistic (few sellers), or oligopsonistic (few buyers) which influence market performance and ultimately consumer prices. Provide conclusions as to the degree of control over prices exercised by member firms.

Trends and Forecasts

1. Describe and summarize trends and forecasts for key product markets. Note the key determinants of the demand for the major products of the sector.
2. Where possible, report or estimate the price elasticities of demand for representative products.
3. Discuss any important events or factors which affect the cost components of the sector. Again, include trends and forecasts of these factors.
4. Present data on representative prices for the sector, and discuss the "behaviour" and trends of these prices.
5. Comment on the conduct and performance of firms within the sector.

Financial Performance Indicators

1. Calculate financial indicators and ratios for the sector and for individual firms within the sector. In other words, one figure for the "industry", and one for each firm is required. These indicators and ratios are to be calculated for the last five (5) years for which data are available.

Extraordinary Conditions

1. Comment on any other extraordinary conditions or factors affecting the sector revealed by this research, and discuss their economic implications.